Advanced Control Method for Hypersonic Vehicles

Completed Technology Project (2013 - 2014)

Project Introduction

This research effort aims to develop software control algorithms that will correct for roll reversal before it happens. Roll reversal occurs when an aircraft is steered in one direction but rolls the opposite way due to aerodynamic conditions. The problem often compounds as a pilot attempts to correct for the motion by over-steering in the original direction, leading to uncontrollable roll. Unexpected yaw and subsequent roll reversal caused the loss of an unmanned hypersonic technology vehicle (HTV-2) overseen by DARPA in 2011. The team has employed novel predictive software within adaptive controller technology to detect conditions likely to result in aircraft roll reversal and then automate compensating maneuvers to avoid catastrophic loss.

Work to date: University of Michigan's retrospective cost model refinement (RCMR) control algorithm has been integrated into a flight simulator and tested with prerecorded, open-source parameter data similar to that from the HTV-2 anomaly. The simulation returned control recommendations that would have prevented the incident, suggesting that RCMR has the potential for preventing future roll-reversal anomaly.

Looking ahead: Next steps involve upgrading the RCMR code to account for a 6-degree-of-simulation environment (forward/back, up/down, left/right, pitch, yaw, and roll) with eventual application in a flight test environment. Partners will include the University of Michigan, DARPA, and aerospace firms.

Benefits

- **Operates independently:** Unlike other standard control systems, this method allows for compensation and control of aircraft roll reversal without a priori knowledge of the dynamics
- **Improves safety:** This technology is expected to prevent crashes that occur due to uncontrolled roll
- **Increases envelope:** RCMR would enable planes to travel safely over a larger envelope

Applications

- Hypersonic jets
- Lifting body–type space vehicles and reentry vehicles
- General aviation aircraft

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Table of Contents

Organizational Responsibility

Responsible Mission Directorate:

Mission Support Directorate (MSD)

Lead Center / Facility:

Armstrong Flight Research Center (AFRC)

Responsible Program:

Center Independent Research & Development: AFRC IRAD

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Anticipated Benefits

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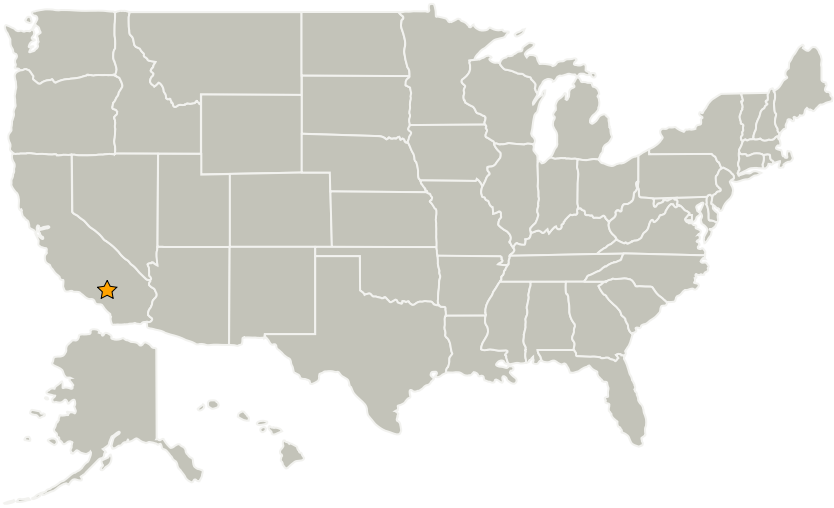
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Armstrong Flight Research Center(AFRC)	Lead Organization	NASA Center	Edwards, California

Co-Funding Partners	Type	Location
Defense Advanced Research Projects Agency(DARPA)	US Government	
University of Michigan-Ann Arbor	Academia	Ann Arbor, Michigan

Project Management

Program Manager:

David F Voracek

Project Manager:

John J Burken

Principal Investigator:

John J Burken

Technology Areas

Primary:

- TX17 Guidance, Navigation, and Control (GN&C)
  - TX17.1 Guidance and Targeting Algorithms
    - TX17.1.1 Guidance Algorithms